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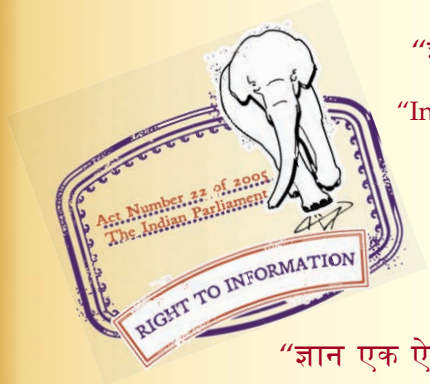
IS 9098 (1979): pure tone audiometers [LITD 7: Audio, Video and Multimedia Systems and Equipment]



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"Knowledge is such a treasure which cannot be stolen"

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IS : 9098 - 1979
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Indian Standard

SPECIFICATION FOR PURE TONE AUDIOMETERS

UDC 616·28—008·185-072·7 : 534·771 : 681·89

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

June 1979

Indian Standard

SPECIFICATION FOR PURE TONE AUDIOMETERS

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Indian Standard

SPECIFICATION FOR PURE TONE AUDIOMETERS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 24 January 1979, after the draft finalized by the Acoutics Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The audiometer covered by this standard is a device using pure tones designed to determine the hearing threshold levels of individuals by:

a) air conduction earphone listening, and

b) bone conduction.

0.3 The purpose of this standard is to ensure that the tests of the threshold of hearing of a given individual on different audiometers, complying with the standard, will give substantially the same results under comparable conditions and that the results obtained will represent a good comparison between the threshold of hearing of the individual and the standard reference threshold of hearing.

0.4 This standard is in no way intended to restrict or inhibit development and incorporation of new features, or other improvements, likely to assist the otologist or audiologist.

0.5 This standard shall be used in conjunction with IS : 4755-1968* which is a necessary adjunct to this standard.

0.6 In this standard, the reference sound pressure is $2 \cdot 10^{-5}$/Pa† and levels are expressed in decibels, relative to this reference pressure.

0.7 While preparing this standard, assistance has been derived from the following:

IEC Pub 177-1965 Pure tone audiometers for general diagnostic purposes. International Electrotechnical Commission.

IEC Pub 178-1965 Pure tone screening audiometers. International Electrotechnical Commission.

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*Reference zero for the calibration of pure-tone audiometers.

†1 Pa = 1 N/m^2.

ANSI S 3·6-1969 Specification for audiometers. American National Standards Institute.

IEC 29C (Central Office) 34-1978 Audiometers. International Electrotechnical Commission.

0.8 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies requirements for a pure tone audiometer.

2. TERMINOLOGY

2.0 For the purpose of this standard, the terms and definitions covered by IS : 1885 (Part III/Sec 5)-1966† and IS : 1885 (Part III/Sec 6)-1967‡ shall apply in addition to the following.

2.1 Audiometer — An instrument for the measurement of hearing acuity.

2.2 Pure Tone Audiometer — An instrument for the measurement of hearing for pure tones and in particular the auditory threshold.

2.2.1 *Manual Audiometer* — A pure tone audiometer in which the signal presentations, frequency and hearing level selection and recording of the results are performed manually.

2.2.2 *Automatic Recording Audiometer* — A pure tone audiometer in which signal presentations, hearing level variation, frequency selection or (for Békésy type) frequency variation and recording of subject responses are implemented automatically.

2.3 Air Conduction — Air conduction is the conduction of sound through the external and middle ear to the internal ear.

2.4 Bone Conduction — Bone conduction is the conduction of sound to the internal ear mediated by vibration of the cranial bones and soft tissues.

*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary: Part III Acoustics, Section 5 Speech and hearing.

‡Electrotechnical vocabulary: Part III Acoustics, Section 6 Acoustical instruments.

2.5 Hearing Level for Pure Tones — The hearing level of a pure tone at a specified frequency, for a specific type of transducer and for a specified manner of application, is the sound pressure level of this signal set up by the transducer in a specified coupler minus the reference equivalent threshold level (abbreviation : HL), for air or bone conduction as applicable.

2.6 Hearing Threshold Level for Pure Tones — The hearing threshold level of a given ear at a specified frequency is the threshold level at that frequency expressed as hearing level.

2.7 Masking — Process by which the threshold of audibility of a sound is raised by the presence of another sound.

2.8 Otologically Normal Subject — For the purpose of this standard an otologically normal subject is understood to be a person in a normal state of health who is free from all signs of symptoms of ear disease and from wax in the ear canal and has no history of undue exposure to noise.

2.9 Mechanical Coupler — Device for the measurement of a bone vibrator performance which presents a mechanical impedance to the bone vibrator equivalent to the impedance presented by the average headbone. It is equipped with a transducer suitable for the measurement of force and acceleration.

2.10 Equivalent Threshold Sound Pressure Level (Monaural Earphone Listening) — The equivalent threshold sound pressure level of an ear at a specified frequency and for a specified type of earphone and for a stated force of application of the earphone to the human ear is the sound pressure level set up by the earphone at that frequency in a specified artificial ear or coupler when the earphone is actuated by that voltage which, with the earphone applied to the ear concerned, would correspond with the threshold of hearing.

2.11 Reference Equivalent Threshold Sound Pressure Level (Monaural Earphone Listening) — The reference equivalent threshold sound pressure level at a specified frequency, for a specified type of earphone and for a specified pattern of coupler or artificial ear is the model value; at the frequency, of the equivalent threshold sound pressure levels of an adequately large number of ears of otologically normal subjects with the age limits of 18 to 30 years inclusive.

3. REFERENCE EQUIVALENT THRESHOLD LEVELS

3.1 The standard values of reference equivalent threshold level shall be in accordance with the values given in **3.1** of IS : 4755-1968*.

NOTE — The values of reference equivalent threshold vibration level for bone conduction are under consideration.

4. REQUIREMENTS OF AUDIOMETER FOR AIR CONDUCTION MEASUREMENT

4.1 The audiometers shall be capable of generating or producing at least 8 tones of frequencies of 250, 500, 1 000, 2 000, 3 000, 4 000, 6 000 and 8 000 Hz. Additional tones of frequencies of 125, 750 and 1 500 Hz may be available as optional facility.

NOTE — The frequencies of 750, 1 500, 3 000 and 6 000 Hz, although are not in accordance with IS : 2264-1963†, are conventionally used for audiometric testing and calibration.

4.1.1 *Accuracy of Tone Frequencies* — The frequency of each tone shall be constant and accurate to within ± 3 percent throughout the presentation.

NOTE — Preset controls to readjust the frequency and level when deviated from their specified value may also be provided.

4.1.2 *Harmonic Distortion* — For the frequencies and hearing level settings listed in Table 1 the maximum level of the harmonics relative to the fundamental of the test tone shall not exceed the values given in Table 2. Distortion shall be measured at the hearing level listed or at the maximum hearing level setting on the audiometer, whichever is the lower.

TABLE 1 OUTPUT LEVELS

(*Clauses* 4.1.2 *and* 4.5)

FREQUENCY, Hz	MINIMUM UPPER LIMIT OF HEARING THRESHOLD LEVEL	
	Air dB	Bone dB
125*	70	—
250	90	30
500	100	50
750*	100	—
1 000	100	50
1 500*	100	—
2 000	100	50
3 000	100	50
4 000	100	50
6 000	90	—
8 000	80	—

*Optional frequencies.

*Reference zero for the calibration of pure tone audiometers.
†Preferred frequencies for acoustical measurements.

TABLE 2 MAXIMUM PERMISSIBLE HARMONIC DISTORTION

(*Clause* 4.1.2)

Frequency, Hz	Air Conduction			Bone Conduction		
	125	250 & 8 000	500 to 6 000	250	500 & 750	1000 to 4 000
Hearing Level, dB	75*	90*	110*	20	50*	60*
Second harmonic	2%	2%	2%	10%	5%	5%
Third harmonic	2%	2%	2%	5%	2%	2%
Fourth and each higher harmonic	0·3%	0·3%	0·3%	2%	2%	2%
All subharmonics	—	0·3%	0·3%	—	—	—
Total harmonics	3%	3%	3%	12%	6%	6%

Note 1 — Due to the limitations of acoustic couplers, artificial ears and mechanical couplers, measurements of harmonics occurring at frequencies above 4 000 Hz may not accurately describe the nonlinear properties of the system. Electrical measurements should be made across the terminals of the transducers at these frequencies.

Note 2 — These distortion values do not necessarily apply to insert transducers; for such transducers, electrical determination of distortion should be made.

*Or relevant maximum output level for the audiometer, whichever is lower.

4.1.2.1 For air conduction, distortion shall be measured acoustically on an acoustic coupler or artificial ear.

Note — Because of the different frequency responses of earphones on human ears and on acoustic couplers, larger distortion values may occur on human ears than those measured on a coupler at lower frequencies, particularly at 125 Hz.

4.1.2.2 For bone conduction, the distortion shall be measured on a mechanical coupler.

Note — Due to non-linearity in the low frequency range of current bone vibrators, reflected in high harmonic distortion products, it is not possible to specify maximum permissible harmonic distortion adequate to ensure that correct bone conduction results are obtained for all types of hearing losses.

4.2 Hearing Level Control (Attenuator) — The sound pressure level of each tone shall be adjustable in steps of 5 dB or less throughout the full range of the instrument. One of the settings shall correspond to the hearing threshold level given in **3.1** for the tone in question. This corresponds to an audiometric hearing loss of 0 dB for this tone. The hearing level dial shall have a fixed index point and only one scale. The maximum levels for air conduction and bone conduction shall be indicated on the hearing level dial.

4.3 Tone Switch

4.3.1 The audiometers shall be provided with a keying device (tone switch) of normally OFF type for the presentation of the test tone to the subject by the operator and its operation shall be such as to establish and eliminate the tone without producing audible transients or extraneous frequencies. The key should be easily operable.

NOTE 1 — When an automatic keying device is used, its characteristics shall be specified by the manufacturer and care shall be taken that it does not influence the results of the measurements.

NOTE 2 — Facilities for locking device may be provided to keep the tone switch in continuous 'ON' position.

4.3.2 In the ' OFF ' position of the tone switch, the steady value of the sound pressure level produced by the earphone in an artificial ear shall be at least 60 dB below the steady value in the ' ON ' position or at least 10 dB below the standard reference equivalent threshold sound pressure level (*see* **3.1**) whichever of these two levels is higher. The build-up and decay times of the test tone shall be as given in **4.3.3** and **4.3.4** respectively.

NOTE — It is essential that the presentation of the test tone shall not be accompanied by audible transients or signals of extraneous frequencies or mechanical noise caused by the operation of the controls. An objective formulation of these demands is difficult but experience shows that, when using the build-up and decay times given in **4.3.3** and **4.3.4** respectively, no difficulties arise.

4.3.3 When the tone switch is moved to the 'ON' position, the time taken for the sound pressure level produced by the earphone to attain −1 dB relative to its final steady value shall not exceed 0·2 second from the instant of operating the switch. The time required for the sound pressure level to rise in a progressive manner from −20 dB to −1 dB relative to its final steady value shall not be less than 0·02 second. At no time during the build up or decay of the tone shall the sound pressure level produced by the earphone attain a value exceeding ± 1dB relative to its steady value in the 'ON' position.

4.3.4 When the tone switch is moved to the 'OFF' position, the time taken for the sound pressure level produced by the earphone to decay from the level of −1 dB to the level of −60 dB relative to its steady value in the 'ON' position shall not exceed 0·2 second from the instant of operating the switch. The time required for the sound pressure level to fall in a progressive manner from −1 dB to −20 dB relative to its steady value in the 'ON' position shall not be less than 0·02 second.

NOTE — The time taken from the instant of operating the switch to the moment when the sound pressure level has decayed to −1dB relative to its steady value in the 'ON' position, shall be as short as possible and shall not in any case exceed 0·3 second.

4.3.5 At no time after operating the tone switch shall the sound pressure level produced by the earphone attain a value exceeding + 1 dB relative to its steady value in the 'ON' position.

4.4 Sound Source — Each audiometer shall be provided with two earphones. Each earphone shall be equipped with ear cushion of supra aural type and shall be provided with suitable spring head band having adequate tension to hold the earphone against the ears to provide a satisfactory seal with a force of at least 4 N. These earphones shall be so designed that it permits close sealing of the ear with a well defined enclosed air volume. It shall be possible to obtain accuracy of positioning. The left earphone shall be marked blue and the right earphone shall be marked red.

NOTE — It is desirable that the ear cushion be of a kind which can readily be cleaned.

4.5 Range of Sound Pressure Levels — The range of sound pressure levels set up by the earphone shall extend from the standard reference equivalent threshold sound pressure level to a higher value, which shall be at least that given in Table 1. An extension below the standard reference equivalent sound pressure level is optional.

4.6 Accuracy of the Sound Pressure and Vibration Levels

4.6.1 The acoustical measurements for the accuracy of the sound pressure level produced by the earphone should be carried out at 1 000 Hz and at 60 dB. At other settings of the attenuator only the electrical measurements should be carried out.

4.6.2 The difference between the actual sound pressure levels of a tone at two neighbouring settings of the attenuator scale shall be within $\pm$ 1dB or by not more than $\frac{1}{\sqrt{10}}$ of dial separation of the difference between the scale readings at the two settings whichever is larger. The measurement shall be done at 1 000 Hz.

4.6.3 The difference between the actual sound pressure levels of a tone at each pair of settings of the attenuator scale shall be within $\pm$ 2 dB of the difference between the scale readings at the two settings. The measurement shall be done at 1 000 Hz.

4.6.4 The overall performance shall be such that the deviation between the actual sound pressure level of a tone, set up by the earphone in an artificial ear, at each setting of the attenuator and the standard reference equivalent threshold sound pressure level, does not exceed the value indicated on the attenuator scale by more than the amount stated below.

The accoustical measurement shall be done at 60 dB at the following frequencies:

Nominal Frequency of the Test Tone, Hz	*Maximum Permissible Deviation,* dB
125*	± 3
250	± 3
500	± 3
750*	± 3
1 000	± 3
1 500*	± 3
2 000	± 3
3 000	± 3
4 000	± 3
6 000	± 5
8 000	± 5

NOTE — If more than one channel for signals and/or noise can be connected simultaneously to a single transducer the output level of either signal (or noise) from the transducer with both channels connected shall differ by less than ± 1dB from the level obtained when one channel is connected. This requirement shall be met at frequencies from 125 to 4 000 Hz and with a tolerance of ± 2 dB at higher frequencies. It shall also apply to hearing levels up to 20 dB below the maximum output level.

5. REQUIREMENTS OF AUDIOMETER FOR BONE CONDUCTION MEASUREMENTS

5.1 Test Tone Frequencies — At least six tones of frequencies, namely 250, 500, 1 000, 2 000, 3 000 and 4 000 Hz, shall be provided. The frequency of each tone shall be constant and accurate to within ± 3 percent throughout the presentation.

5.2 Contact Area of Bone Vibrators — A bone vibrator shall be provided having a plane circular contact area of 175 ± 25 mm².

5.3 Headband — A specified headband shall be provided to hold the bone vibrator in position and to exert a static force of 5·4 ± 0·5 N. The headband shall permit the simultaneous use of one of the air conduction test earphones as a source of masking noise to the ear not under test.

NOTE — The mastoid is recognized as a suitable location for contact of the vibrator with the head, but this does not preclude the use of other contact locations, for example, the forehead, provided the location be clearly identified and corresponding calibration data furnished.

*Optional frequencies.

5.4 Calibration — The bone vibrator shall be calibrated according to the normal threshold of hearing for bone conduction using the mechanical coupler. The zero setting of the audiometer hearing level dial for air conduction shall apply also for bone conduction for a stated placement of the bone vibrator.

6. GENERAL REQUIREMENTS

6.1 Warm-Up Time — The maximum warm-up time shall be specified by the manufacturers and shall not exceed 10 minutes when the unit has been stored at room temperature. The performance requirements of this standard shall be met after the stated-warm-up time has elapsed and after any setting-up adjustments have been carried out in the manner prescribed by the manufacturer.

6.2 Stability with Respect to Variations in the Environmental Conditions — The audiometer shall be capable of operating with the specified requirements at all temperature within the range of + 15 to + 35°C when the relative humidity is within the range from 30 to 90 percent. The checking shall be made with the attenuator set at 70 dB hearing threshold level and the frequency at 1 000 Hz.

6.3 Battery Level Indicator — A suitable battery level indicator shall be provided to ensure that the battery voltages are within the specified limits.

6.4 Housing — Housing shall be an integral part of the audiometer. The protector cover shall be provided with suitable windows where necessary.

6.5 Carrying Means — A suitable carrying means shall be provided. Facilities for carrying accessories shall be provided. Where a separate carrying case is provided, it shall also have facilities for storing the normal accessories.

6.6 Unwanted Acoustic Radiation

6.6.1 *General* — Objective acoustical measurements may be impracticable for testing certain characteristics of audiometer performance. In such cases, subjective tests described in Appendix A may be performed using a test crew consisting of an adequate number of selected otologically normal subjects whose hearing threshold levels shall not exceed 10 dB for the test frequencies 250 to 4 000 Hz and not exceed 20 dB for the frequencies 125, 6 000 and 8 000 Hz.

6.6.2 *Extraneous Sound of Electrical Origin from the Earphone* — Extraneous sounds from any cause shall be of such a magnitude that the sound pressure level in any one-third octave band is at least 10 dB below the signal from the ' ON ' earphone (suggested subjective test procedures to supplement these measurements are described in Appendix A).

6.6.3 *Unwanted Sound from a Bone Vibrator* — At any test frequency of 4 000 Hz or lower, and at higher test frequencies where provided, the bone vibrator shall not radiate sound to such an extent that the sound reaching the test ear by air conduction through the unoccluded ear canal might impair the validity of the bone conduction measurement. As judged by an otologically normal test subject, the sound radiation from the bone vibrator shall be heard at a level at least 10 dB below the level which the vibrator generates by bone conduction when in contact with the head.

A test for conformity with this requirement shall be made as follows:

a) First determine the bone conduction threshold in the usual manner,

b) Then determine the auditory threshold with the vibrator in approximately the same position except that its normal contact area is covered with a vibration isolation pad providing an attenuation of at least 20 dB above 1 000 Hz. The attenuation of the isolation pad may be measured on a mechanical coupler. The auditory threshold shall be at least 10 dB greater than before.

The mean shall be at least 10 dB greater than before. The mean shall be taken of the test results of at least 10 otologically normal ears.

NOTE — The sound radiation of the bone vibrator may be lower in some cases and at some frequencies when loaded with such a pad compared with the radiation when loaded with the human mastoid.

6.6.4 *Unwanted Sound from an Audiometer* — Any sound due to the operation of audiometer controls during the actual listening test, or to radiation from the audiometer, shall be inaudible at each setting of the hearing level dial up to and including 50 dB. The test for this requirement shall be made by an otologically normal subject wearing a pair of disconnected earphones and located at the recommended test position, the electrical output of the audiometer being absorbed in a resistive load equal to the impedance of the earphone at 1 000 Hz; where a bone conduction facility is available, the test shall be repeated with one ear only occluded by an earphone.

NOTE — This limitation on noise from controls applies to any noise that could furnish the patient with clue which might influence the test results. It is not intended to apply to a mechanism such as an output selection switch or a detent on the frequency switch, that would emit noise which would occur when the subject is not actually being tested.

6.7 Masking Source

6.7.1 Audiometers shall provide broad band weighted or narrow band masking sounds for the given pure tone signals. All measurements of the masking noise levels shall be made acoustically in the coupler or in the artificial ear. Analysis of noise spectrum should be performed with a 1/3-octave or a narrow-band analyzer. Audiometer shall consist of an ' ON '/' OFF ' switch for the masking sound.

NOTE — Masking sounds may also be transmitted through the bone vibrator.

6.7.2 *Narrow-Band Noise* — The noise oands shall be centred geometrically around the test tones. The recommended band limits for the masking sound are given in Table 3. The minimum attenuation rate outside the passband should be at least 12 dB per octave.

TABLE 3 NARROW-BAND MASKING SOUNDS (UPPER AND LOWER FREQUENCY LIMITS AT THE 3 dB POINTS OF THE SPECTRAL DENSITY)

CENTRE FREQUENCY, Hz	LOWER LIMIT, Hz		UPPER LIMIT, Hz	
	Maximum	Minimum	Minimum	Maximum
125	105	112	140	148
250	210	223	281	297
500	420	445	561	595
750	6 1	668	842	892
1 000	841	891	1 120	1 190
1 500	1 260	1 340	1 680	1 740
2 000	1 680	1 780	2 240	2 380
3 000	2 520	2 680	3 370	3 570
4 000	3 360	3 560	4 490	4 760
6 000*	5 040	5 360	6 740	7 140
8 000*	6 720	7 120	8 980	9 520

NOTE — These band limits correspond to one-third octave as a minimum and one-half octave as a maximum. These bands are wider than the critical bands and thus require approximately 3 dB more energy than critical bands for effective masking. These bands are recommended to minimize perceived tonality in the masking noise.

*Due to the limitations of existing couplers and artificial ears, acoustic measurements are not required.

6.7.3 *Broad-Band Noise* — If broad-band (random) noise is used it shall have a spectrum pressure level, as measured in the acoustic coupler or artificial ear, which is uniform within $\pm$ 5 dB relative to the 1 000 Hz level over the frequency range of 250 Hz to 6000 Hz.

6.7.4 *Weighted Random Noise for Pure Tone* — If the audiometer provides weighted random noise for pure tone masking, its spectrum should be so shaped that for zero masking the sound pressure level in each one-third octave band is equal within ± 5 dB from 250 Hz to 4000 Hz to the reference equivalent threshold level for each test frequency when measured in the acoustic coupler or artificial ear.

6.8 Masking Sound

6.8.1 *Intervals* — The masking level dial should preferably have only one scale and a fixed index point. The masking level shall be adjustable in steps of 5 dB or less. However, in view of the considerable numerical differences in masking level readings for wide-band narrow-band noise, a double scale arrangement may be accepted.

6.8.2 *Reference Levels*

6.8.2.1 For narrow-band noise, the level control shall be calibrated in decibels of effective masking. The masking noise in each 1/3-octave band centered at the frequencies specified shall have a sound pressure level equal to the corresponding reference equivalent threshold level + 3 dB at the frequency of the pure tone about which the band is centred.

6.8.2.2 For other noises, the masking level control shall be calibrated in sound pressure level or in effective masking as measured with the earphone on an artificial ear or acoustic coupler.

6.8.3 *Specification of Masking Effect* — For each type of audiometer and earphone, combination, the manufacturer shall supply data showing the masking effect for each test signal and the corresponding sound pressure level on the coupler or artificial ear.

6.8.4 *Accuracy of Masking Levels* — The level of the masking noise produced by an earphone shall not differ from the indicated value by more than + 5, — 3 dB. The measured difference in output between any two successive designations of masking level shall not differ from the indicated or 1 dB, whichever is smaller. Measurements for conformity with this requirement may be made acoustically or electrically at the input to the transducer with the transducer attached to a coupler. Alternatively, the transducer may be replaced by a dummy load which simulates the transducer impedance at that test frequency.

6.8.5 *Masking Level Range* — The masking noise shall be available at levels at least sufficient to mask tones at 60 dB hearing level at 250 Hz, 75 dB at 500 Hz, and 80 dB from 1 000 Hz to 4 000 Hz. However, the overall output sound pressure level of the masking noise shall not exceed 125 dB. The masking noise level shall be adjustable over a range from 0 hearing level to the above hearing levels.

7. POWER SUPPLY

7.1 The audiometer shall be capable of operating with the specified requirements either from ac mains or battery or both within the limits of voltages as specified below.

7.1.1 *Battery Operations* — The audiometer shall operate from suitable batteries as specified by the manufacturer. The number and type of cells shall be indicated. The battery shall be housed inside the audiometer itself. The limits of the battery voltages with which the audiometer shall operate shall be specified by the manufacturer.

7.1.2 *Mains Operation* — The audiometer shall operate from 240 V $\pm$ 10 percent, 50 Hz ac power source. The audiometer shall be provided either with built-in or external eliminator.

8. MARKING

8.1 The audiometer shall be clearly and indelibly marked with the following:

a) Manufacturer's name and trade mark,

b) Type or model No. and serial number,

c) Supply voltage, and

d) Country of manufacture.

8.1.1 The audiometer may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

9. SAFETY REQUIREMENTS

9.1 In so far as mains operation is concerned, it shall conform to the relevant requirements specified in IS : 616-1957*.

*Code of safety requirements for mains-operated radio receivers.

10. METHODS OF MEASUREMENTS

10.1 General (for Air Conduction)

10.1.1 All the requirements for air conduction in this standard are expressed in acoustical terms, for example, sound pressure level produced by the earphone in an artificial ear.

10.1.2 Measurements for determining compliance with the standard shall preferably be carried out acoustically. In certain cases, however, because of large number of measurements or very low sound pressure level involved, corresponding voltage measurements may be used.

For example, (a) Measurement at sound pressure levels below 50 dB, and (b) Calibration of attenuator setting other than at 60 dB at various frequencies (*see* **4.6.4**).

10.1.3 No measurements need be made of any individual harmonic component if it is less than that corresponding to the threshold for the harmonic frequency.

10.2 Calibration of the Sound Source

10.2.1 The objectve calibration of the earphone, including any detachable ear cushion provided, shall be carried out with an artificial ear according to the following procedure:

a) For certain types of earphones in use as standards, the calibration is based on the reference equivalent threshold sound pressure, specified in **3.1** for stated patterns of artificial ears.

b) Transference of the standard pressure values given in **3.1** to values which are applicable to another type of earphone shall be made by a loudness balancing procedure. A typical earphone is selected as reference after objective examination of at least three earphones of the new pattern. The respective voltages required by the standard earphone and the typical earphone to produce equally loud tones, are determined by alternate listening or balancing at a low or moderate loudness level, these judgements being made by a team of not less than 10 otologically normal subjects between the age limits of 18 to 25 years inclusive, whose hearing threshold level (audiometric hearing loss) does not exceed 15 dB at the test frequencies. The resulting ratios of voltages then applied to the respective earphones when attached to the coupler, will allow the determination of what pressures generated in the coupler by the typical earphone correspond to the standard reference pressure generated by the standard earphone.

Separate determinations shall be made for each frequency concerned mentioned in **4.1**. The application of the earphones to the ears of the subjects shall correspond as closely as possible to actual usage.

To obtain standard pressure values applicable to a type of coupler other than that specified, a direct comparison may be made of the pressures generated in the standard and the coupler under examination by the standard earphone with a given voltage applied to the earphone.

For an earphone and a coupler, both of which are different from the standard types, the two indicated procedures may be combined to obtain applicable standard reference pressure values.

10.2.2 The loudness balance shall be carried out at least for the frequencies mentioned in **4.1**. The application of the earphones to the ears of the subjects shall correspond as closely as possible to actual usage. The reference equivalent threshold sound pressure levels in the artificial ear, as obtained from these measurements, shall be taken as the basis for the artificial ear calibration of other earphones of the same pattern.

11. INSTRUCTION MANUAL

11.1 An instruction manual shall be supplied with the audiometer with the following information included:

a) A description of the facilities provided and full operating instructions.

b) Identification of the transducers and their reference equivalent threshold levels, their origin and the coupler used for calibration shall be stated. In case of bone vibrators, it shall be stated if the calibration applies to occluded or unoccluded test ear and for forehead or mastoid place of application.

c) Frequency response characteristics and masking effect of masking noise shall be provided.

d) The permissible supply variation and environmental conditions.

APPENDIX A

(*Clauses* 6.6.1 *and* 6.6.2)

SUBJECTIVE TESTS SUGGESTED FOR SUPPLEMENTATION OF AUDIOMETER PERFORMANCE VERIFICATION

A-1. A room is considered sufficiently quiet for the purposes of these tests if a crew of otologically normal listeners with their ears unoccluded is unable to detect any ambient noise during the test period.

NOTE — When testing only the air conduction performance of an audiometer, the requirements of clause **A-1** may be checked by observers wearing the disconnected earphones of an audiometer.

A-2. Any signal other than the test tone from the selected earphone for any setting of the hearing level control up to and including 70 dB of hearing level should be such that an otologically normal hearing test crew under conditions of clause **A-1** is unable to detect it. This test should be made at all frequencies and levels of the masking signal, where provided, and with the tone switch in the 'ON' and 'OFF' positions. For settings above 70 dB, an external attenuator should be inserted in the subject's earphone. Tests for compliance at settings above 70 dB should be made with the external attenuator set to a value equal to the number of decibels above the 70 dB audiometer setting. The opposite earphone shall be disconnected and the audiometer output terminals suitably loaded during the test.

A-3. For audiometers intended to be used with the subject in the same room, under the same testing conditions and procedures as in clause **A-2** but with the observer listening through the opposite earphone, with the selected earphone disconnected and the audiometer terminals loaded, no unwanted sound should be detectable up to and including the 70 dB setting of the test tone attenuator.

A-4. For audiometers intended to be used with the subject in the same room, no direct radiated sound of any kind should be detectable from the audiometer, nor should mechanical noises from the operation of the attenuator or tone switch be audible when operated with normal care. These tests should be conducted under the same conditions as in **A-2** but with both earphones disconnected and audiometer terminals loaded. The test subjects wearing disconnected earphones should be located 1 m from the audiometer. If bone conduction measurements are provided by the audiometer, the listeners shall have at least one ear unoccluded.